
REMARKS

Claims 1-30 are pending in the application. Independent claims 1 and 20 have been revised to recite a solid oxide fuel cell that “directly operates with a sulfur-containing hydrocarbon fuel that does not have to undergo prior treatment to remove organic sulfur compounds.” Claims 1 and 20 also have been revised to recite that the fuel cell anode contains at least ceria. Support for the amendment can be found, *inter alia*, on page 13 of the specification. Claim 54 has been added to recite a fuel cell similar to that of claim 1, except the anode contains at least copper. Support for this claim can be found in Example 5 on pages 22 and 23 of the specification. No new matter is presented by the amendment. Accordingly, applicants respectfully request entry thereof and reconsideration of claims 1-30 and 54 in light of the following remarks.

On pages 1 and 2 of the Action, claims 1-30 are rejected under 35 U.S.C. §112, second paragraph for being indefinite. While applicants disagree with the Examiner, applicants have canceled the putatively offending language from the claims thereby obviating this rejection. Applicants submit that the claims are definite and adequately supported by the disclosure. Should the Examiner believe that alternative language is more appropriate to describe this aspect of the invention, applicants welcome any suggestions in this regard.

On pages 2-6 of the Action, claims 1-6, 9-27, and 30 are rejected under 35 U.S.C. §103(a) as being unpatentable over Wallin, U.S. Patent No. 6,017,647 (“Wallin”) in view of Anumakonda. The present Action repeats the previous rejection. For the reasons set forth in applicants’ response filed on September 17, 2003, this rejection is respectfully traversed.

The solid oxide fuel cells require the fuel cell to contain a fuel comprising a sulfur-containing hydrocarbon. Neither Wallin nor Anumakonda disclose this feature of the invention. Indeed, Anumakonda teaches directly away from this aspect of the invention by requiring reformation of the sulfur-containing fuel prior to the fuel cell. Thus, the solid oxide fuel cell of Anumakonda does not contain a sulfur-containing hydrocarbon. Rather, as noted by the Examiner on page 9 of the Action, the product gas from Anumakonda’s partial oxidation process (product gas that has been treated to remove sulfur) is used directly in the fuel cell system. The solid oxide fuel cell therefore does not contain a sulfur-containing hydrocarbon because the product gas contains no sulfur — only hydrogen and carbon monoxide.

The claims as initially presented recited “a solid oxide fuel cell comprising,” which as noted by the Examiner is open ended. The claims also require, however, the fuel cell to contain a fuel comprising a sulfur-containing hydrocarbon. Thus, to the extent that the prior art such as Anumakonda reforms the sulfur-containing fuel prior to introduction to the fuel cell, and consequently only introduces a non-sulfur containing hydrocarbon fuel, the prior art does not disclose or suggest a fuel cell that includes a sulfur-containing hydrocarbon.

A person skilled in the art would not have been motivated to make the hypothetical combination asserted in the Action because such a combination increases the complexity and cost of Wallin’s fuel cell by requiring additional unit operations up-stream from the solid oxide fuel cell. Even if the disclosures were combined, the combined teachings would not result in a solid oxide fuel cell including a sulfur-containing hydrocarbon, as recited in the present claims. Rather, the combined teachings would result in sulfur-removal unit operations up-stream from Wallin’s fuel cell, and then introduction of hydrogen and carbon monoxide only into the fuel cell. The combination of Wallin and Anumakonda therefore fails to render obvious the present claims, and applicants respectfully request that the Examiner reconsider and withdraw this rejection.

Finally, neither Wallin nor Anumakonda disclose a solid oxide fuel cell containing ceria and a fuel comprising a sulfur-containing hydrocarbon. The present inventors discovered, among other things, that the presence of ceria in the anode is beneficial because it provides electronic conductivity, and it provides catalytic activity for the oxidation of hydrocarbons (*see*, page 13 of the specification). The claims are allowable over the prior art for at least these reasons.

On pages 5-7 of the Action, claims 1, 2, 7, 8, 20, 28 and 29 are rejected under 35 U.S.C. §103(a) as being unpatentable over Wallin in view of Fasano, *et al.*, U.S. Patent No. 6,051,330 (“Fasano”). The Action repeats the previous rejection. For the reasons set forth in applicants’ response filed on September 17, 2003, this rejection is respectfully traversed.

The Action apparently takes the position that the alcohol feeds disclosed in Fasano inherently have sulfur contents of from about 1 ppm to about 5000 ppm. The Examiner correctly notes the legal requirements to establish inherency insofar as the missing feature must necessarily be present in the prior art. The Action has failed, however, to provide any evidence that the alcohol feeds disclosed in Fasano “necessarily” have a sulfur content of

from about 1 ppm to about 5000 ppm. Rather, to support the inherency argument, the Action has made the unsupported conclusion that Fasano and the present application utilize similar alcohols.

The alcohols used in the present application are not similar to those described in Fasano. Applicants have previously provided the Examiner with documents showing that the sulfur content of commercially available methanol for use in fuel cells is typically zero, and at most about 0.5 ppm. Absent any disclosure to the contrary, a person skilled in the art would recognize that the methanol disclosed in Fasano is precisely the type of methanol typically used in fuel cells — that is, methanol with no sulfur.

In sharp contrast to the Fasano disclosure, the fuels used in the present specification require sulfur. To the extent that commercially available hydrocarbon fuels contain no sulfur, such as decane, sulfur is added to the fuel in the examples to provide a sulfur-containing fuel. The examples reveal that thiophene was added to hydrocarbons to provide a sulfur-containing hydrocarbon.

The alcohol fuels disclosed in the specification and recited in the claims must contain sulfur. Fasano discloses that heavier hydrocarbons, such as JP8 that contain sulfur, are not efficient because they result in carbonaceous build-up in the anode. Thus, a person skilled in the art would understand that the methanol and ethanol disclosed in Fasano are of the type disclosed in the documents previously provided to the Examiner that describe alcohols used in solid oxide fuel cells as containing no or negligible sulfur. A skilled artisan reading Fasano's disclosure would have been motivated to use feed streams containing no or negligible sulfur because Fasano recognizes that sulfur causes deleterious reactions in the fuel cell (*e.g.*, carbonaceous build up at the anode), and seriously decreases its efficiency.

The present Action apparently disagrees with Fasano's express teaching by making the following statement: "Alternatively, it would have been within the skill of the ordinary artisan to lower the production cost of alcohol by eliminating the desulfurization process because one of ordinary skill in the fuel cell art would recognize it is cost-effective to use alcohol having relative high sulfur content (>1 ppm) as fuel for a solid oxide fuel cell."¹

¹ The Action's previous statement (*e.g.*, the other alternative) that it would have been obvious to use a light hydrocarbon fuel "because Fasano et al. teach the use of a light hydrocarbon fuel can reduce the build-up of carbonaceous material in the anode" is a non-sequitur. Fasano discloses that one can reduce the build-up of carbonaceous material in the anode by using fuels that do not contain sulfur. Thus, the light hydrocarbon

There is no prior art that applicants are aware of that support this statement, and the prior art cited by the Examiner teaches exactly the opposite. Sure, it would be cheaper to use a fuel that does not require reformation to remove sulfur. This was one of the motivating factors behind the present invention. But the prior art (including Fasano) suggested that sulfur could not be processed in a solid oxide fuel cell without seriously decreasing its efficiency.² In fact, sulfur could not be processed directly by a typical solid oxide fuel cell until the present applicants discovered a fuel cell that directly operates with sulfur-containing hydrocarbon fuels (that is, a fuel cell that contains, *inter alia*, at least ceria and/or copper in the anode).

The present inventors have discovered a solid oxide fuel cell that directly operates with sulfur-containing hydrocarbons. Consequently, the methanol and ethanol described in the present application would contain sulfur, and need not be the methanol and ethanol typically used in fuel cells. Fasano's disclosure of methanol and ethanol therefore fails to inherently describe a fuel cell including a sulfur-containing hydrocarbon, as recited in the present claims.

In sum, skilled artisans would not have been motivated to combine the cited art in the manner suggested in the Action. Even if combined, the combined teachings do not disclose or suggest the claimed invention because the art fails to disclose that the methanol fuel of Fasano inherently has a sulfur content within the claimed range — indeed, it suggests otherwise. The combination of Wallin and Fasano therefore fails to render obvious the present claims. Accordingly, applicants respectfully request that the Examiner reconsider and withdraw this rejection.

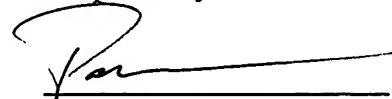
would not contain sulfur. The obviousness conclusion statement in the Action therefore goes directly against Fasano's teachings.

² In this regard, the Fasano disclosure suggests that fuels containing sulfur would be less cost efficient because they decrease the efficiency of the cell. The foundation upon which this alternative obviousness conclusion is based directly contradicts the teachings of the prior art.

In view of the foregoing, applicant respectfully submits that the present claims are in condition for allowance. An early notice to this effect is earnestly solicited. Should there be any questions concerning this response, Examiner Yuan is invited to contact the undersigned at the telephone number listed below.

8/11/04
Date

Respectfully submitted,


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